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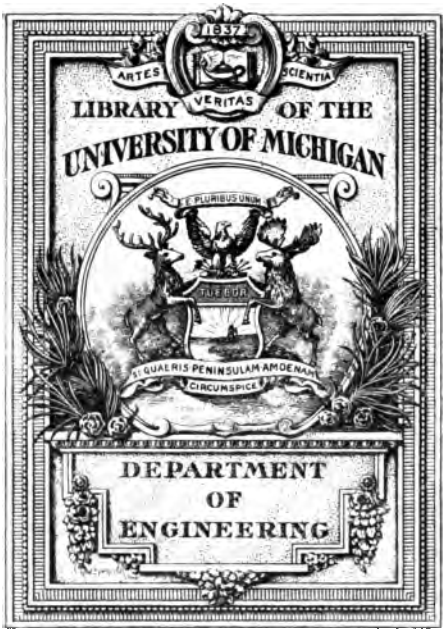

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Light, Heat and Power.

With Partial List of Deaths from Electr
Lighting Circuits.

ELECTRICAL DISTRIBUTION

OF

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HEAT, LIGHT AND POWER.

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BY

HAROLD P. BROWN, ELECTRICAL ENGINEER,
45 & 47 WALL STREET, NEW YORK.

WITH PARTIAL LIST OF DEATHS FROM ELECTRICAL LIGHTING APPARATUS,

AND ADDRESS BY

JOHN MURRAY MITCHELL, COUNSELOR AT LAW,

ON

Legislative Control of Dangerous Electrical Currents.

NEW YORK:
PRESS OF J. W. PRATT & SON, 73 TO 79 FULTON STREET.
1889.

PREFACE.

Believing that the subject of electrical distribution and its attendant dangers is of interest to a wider circle of readers than is represented by the membership of the Medico-Legal International Congress, the writer republishes his address, with a list of deaths from electric lighting apparatus and the able paper of Mr. John Murray Mitchell. To prevent any hasty and ill-advised legislation on the matter, it is necessary that it should receive careful consideration from scientific, legal and business standpoints. Though the writer would favor making the law suggested by Mr. Mitchell apply solely to the high-tension alternating current on the ground that the continuous current can be made safe, it will perhaps serve as a basis for discussion which could not otherwise be obtained.

The slaughter of innocent men by dangerous electrical systems will sooner or later be checked by the passage of laws prohibiting or regulating deadly pressures. High pressure is in many localities necessary for economical distribution of electrical service, and the law should not, in the writer's opinion, set any limit except that imposed by the capacity of the current under such pressure to produce death in a human being by leakage to the ground from its conductor.

A MEDICO-LEGAL VIEW

—OF—

ELECTRICAL DISTRIBUTION.

Address by HAROLD P. BROWN, *Electrical Engineer; before the International Medico-Legal Congress, at Steinway Hall, June 4th,* 1889.

The marvelous advance made during the past ten years in the adaptation of electricity to the needs of modern life is but a mere suggestion of what the next decade will bring us. Millions of dollars have already been invested in electric lighting alone, and our cities are gridironed with copper wires, but a mere fraction of the demand for light has as yet been filled. Our engineers are beginning to realize that, great as is the field for lighting, the field for motive power in factories and dwellings is tenfold greater. And beyond this lies an unexplored territory—heating, cooking and refrigerating by electricity, whose extent is beyond computation. To get an idea of the growth possible to an electrical industry in this country one needs only to recall that the telephone, which was invented in 1876, had, at the close of the year 1888, 411,511 instruments in use, with 243,764 miles of wire. During the same period electric lighting has assumed practical commercial shape, and it is estimated that over one million horse power is now in daily use for this purpose. Looking at the network of wires now used for intercommunication alone, and multiplying their number by one thousand and their cross-section by one hundred, which is a low estimate of the requirements of the future for all uses, we can realize what a tremendous problem is involved in the distribution of this amount of metal. Electricity will do all the hauling and street car work in the cities of the future, while the horse with his omnipresent manure and the rough footing he requires for heavy loads, will be relegated to pleasure driving and farm service. The streets will then be smoothly paved and clean, and the noise and rattle of to-day forever silenced. The air will no longer be polluted with smoke, for one immense station provided with triple or quadruple expansion engines and furnaces in which combustion is complete, will supply heat, light, power and motion. The consequent addition to human health, comfort, and length of life by the banishment of dirt and noise will be enormous. Electrical disinfection and sewage purification are already in use, and since we can command immense volumes of electricity, it is not improbable that a better understanding of the laws of meteorology will enable us to at least partially control the weather and thus avoid the evil effects of severe changes and extreme temperatures. But to offset these advantages, earth and air are filled with wires, many of which may be charged with swift and invisible death which may overtake the most cautious in a myriad of unseen ways. If, then, the near future is to see a thousand electrical horse power distributed where now we have but one, it is clearly the physician's duty to point out the dangerous currents, and it remains for the lawyer to secure wise legislative action preventing the adoption of systems or apparatus which needlessly jeopardize human life or health. What work could be more appropriate than this for an International Congress of the Medico-Legal fraternity? The list of deaths from electric lighting, which forms an appendix to this paper, numbers, though incomplete, over 91 in the past few years; yet it must be borne in mind that not one street in a hundred or one building in a thousand is as yet lighted by electricity, and more than half the house lighting now done is the work of the continuous current used at a pressure that cannot possibly prove fatal. The subject evidently deserves your serious attention, since this list proves that I am no mere alarmist. There are also many maimed and crippled men who are the victims of the false economy which uses dangerous systems of electrical distribution in order to make an apparent saving in first cost of equipment. As an example of the injury which is liable to be inflicted upon any person in a city having a high-tension alternating current station, Mr. W. J. Bell, of St. Paul, has been invited to be present to-day. This unfortunate young man has had his nervous system severely if not permanently wrecked by touching, while holding a district messenger service wire, a pole step-iron which happened to be in contact with a Westinghouse wire some distance away, by means of a guy to a pole on the opposite side of the street. This was on a dry day and the insulation of the wire was apparently uninjured. It is interesting to note that, although terribly injured, Mr. Bell was unconscious of any sensation of pain. Dangerous electrical systems are being rapidly installed in all parts of the country, and, in the interests of human life and health, prompt action is imperatively demanded. It will not do to rely upon the presumption that the electric light or power people *must* sufficiently guard public welfare in order to protect their own business. Nor will it do to rely upon their own statements, for if you listen to the stories told by the worst offenders in this line, you will hear that their system is "perfectly safe," and that the dead man's "carelessness" caused each fatality. This was the same cry that was raised by the oil refiners when it was first proposed to require a high fire test by law. Nor should we accept as an infallible guide the so-called "professional scientist" who nowadays seems to believe that his opinion must necessarily coincide with the wishes of the corporation which retains him. No matter if scientific accuracy must be sacrificed, for science gives its rewards only in return for work accomplished and not for written opinions designed to assist stock-jobbing. When the water gas question was under discussion some years ago, one of this fraternity gave his written opinion to a New York gas syndicate that a small percentage of carbonic oxide in illuminating gas was necessarily fatal. Shortly after, he was "acquired" by a water gas system and testified without hesitation that thirty-two per cent. of carbonic oxide need not be regarded as detrimental. This same authority is now a vehement advocate of the "safety" of a notoriously dangerous electrical system,—the one that has crippled Mr. Bell and Mr. Young,—that has killed a score or more of men in the past few years; that has been adopted by the State of New York for electrical executions upon the advice of the Medico-Legal Society. This class of men is responsible for the favorable action taken by the underwriters in allowing the dangerous alternating current to be used so recklessly as it is in this city and elsewhere. Even the constructing engineers of this system admit that insurance regulations and inspections outside of New England, Philadelphia and Chicago are of little practical value. The only safe and proper course is to have a thorough examination made by unpurchasable medico-legal experts and laws in accordance with their recommendations submitted and urged for passage. But it may be said that the laws already in force give the various boards of health full jurisdiction over any "business, matter or thing dangerous to life or detrimental to health." True, but while every other source of danger is manifest to one or more of the senses, electricity is silent, impalpable, odorless, invisible. A man in the lawful pursuit of business or pleasure may be flashed out of life or have his nervous system hopelessly shattered by a contact between a metal railing and a damp pavement simply because some electric lighting company chooses to use a dangerous current or neglects safeguards on account of their expense. Special legislation is therefore needed to prevent these hidden dangers. Burying the wires is no protection unless you bury with them lights and motors; Chicago has never had overhead electric light wires, and yet at least six men have been killed in that city by electricity. The wires of the telephone, telegraph, messenger service, fire or burglar alarm, etc., while harmless in themselves either above or below the surface, may be made death-dealing by the presence of a dangerous system of electric light or power. Clearly the best course is prevention; it is far easier to keep out dangerous systems than it is to drive them out after they have once secured a foothold. Granting that the laws now in force give the boards of health ample jurisdiction, it is nevertheless necessary that some scientific commission should clearly point out what is dangerous and what is safe, in order that protection to life and health may be secured without putting any safe and legitimate electrical systems under needless restrictions. If corporations are permitted, as at present, to enmesh our cities with wires carrying death-dealing currents,—currents which can escape and produce *death through any known insulation*, —it will not be long before the public clamor will cause the adoption of laws hampering if not destroying all electrical industries. During the past year a long series of careful experiments was made by the writer to determine the comparative danger to life of the various forms of electrical currents, the results of which were considered at the December meeting of the Medico-Legal Society. This work proved beyond question that the continuous current, which flows steadily in one direction, was in itself perfectly safe, at least up to a pressure of 1,400 to 1,500 volts; that devices suggested by the writer would make its use reasonably safe in light and power systems up to 3,000 volts; that an interrupted or pulsating current was dangerous; and that an alternating current, known by physicians as "voltaic alternatives," whose impulses are rapidly reversed in direction, was deadly at a very low pressure. These conclusions are verified by the death record, for out of the NINETY-ONE fatalities whose particulars I have been able to obtain, not one is due to the low-tension continuous current; but nine to the high-tension continuous, fifty-five to the pulsating, and twenty-seven to the alternating. The latter has but recently come into extensive use, and its plants are supplied with new insulated wire; as this insulation deteriorates with age, and as the system is extended, its death list will be rapidly increased. The physiological effects of these currents upon nerves and muscles also bear out these conclusions, since it is well known that the continuous current from a galvanic battery causes no painful sensations at limited pressures; interrupting the same current produces severe muscular shocks, while alternating it intensifies the shocks. About fifty of the deaths from arc light apparatus were caused by the victim's handling a circuit *already grounded*, while he at the same time touched a second ground, thus completing a circuit through his body. It is obvious that if automatic apparatus should shut down the current at the instant the first ground occurred, or reduce the pressure below the killing point, there would be no more deaths from this cause. Such apparatus has been publicly exhibited by the writer, and it has been shown that current sufficient to operate the device can pass through a living being without ill effects. All of the deaths from the high-tension continuous current were evidently caused by what is known as an "extra-current," which is a rapid rise and fall of the pressure caused by breaking a circuit in which is interposed a large electro-magnet. This can be prevented by exciting the dynamo field-magnets from a second dynamo or by using the apparatus suggested by M. D'Arsonval or that designed by the writer. It is therefore an easy matter to make *perfectly safe* the use of the high-tension continuous current for arc or incandescent lighting, but these devices are no protection against the alternating current. Leaving for a moment the danger question, I wish to direct your attention to the present methods of electrical distribution; to the direction and apparent tendencies of growth, and to the probable result if wise legal restraints are not forthcoming. The electrical terms which it is necessary to use in this connection are the volt, the unit of electromotive force or pressure, analogous to "head" or pressure in hydraulics; the ampere, the unit of current volume, which may be compared to the amount of water flowing through a pipe, and the ohm, the unit of resistance or friction. As in hydraulics, the product of pressure and volume (volts and amperes) is expressed in horse power. Coming now to electrical distribution, it is evident that the same amounts of horse power may be distributed by a large flow of water or current under low pressure, or by one-tenth the volume with ten times the pressure. This roughly outlines the two leading methods of electrical distribution, the multiple arc, using large volume and low but constant pressure, and the series, using small but constant volume and high pressure. The series system, which is preferable for arc lights, comprises a single circuit leading from one terminal of the dynamo, through each lamp, and returning to the other terminal. Every lamp thus receives the entire current, but uses up only a fraction of the total pressure. (Fig. 1).

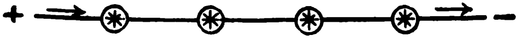

Fig. 1.—Series System.

An apt illustration of this system is a series of water wheels operated by a small stream of water which has a fall of say ten feet through the first wheel, then flows to the second wheel, drops ten feet through it, and so on. The entire amount of water has finally passed through each wheel and the dynamo then hoists it back to its first level. But each wheel has used only a portion of the total fall (Fig 2). In the multiple arc system, on the other hand, one pole of each lamp is connected to the positive and the other to the negative terminal of the dynamo. It is comparable to a large volume of water with a total fall of but ten feet, supplying a number of water wheels placed on the same level. A small portion of the water passes through each

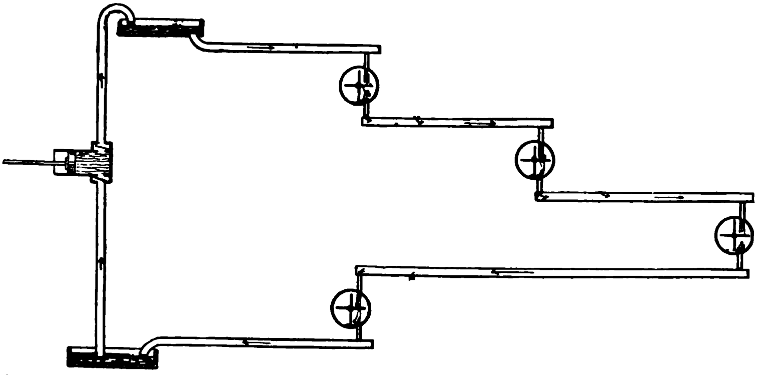

Fig 2.—Water Analogue of Series System.

wheel, but each has the benefit of the entire fall. (Figs. 3 and 4).

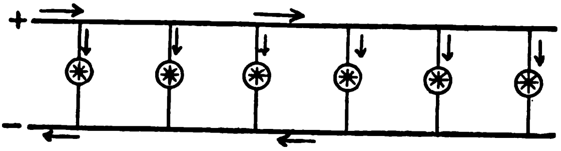

Fig. 3.—Multiple Arc System.

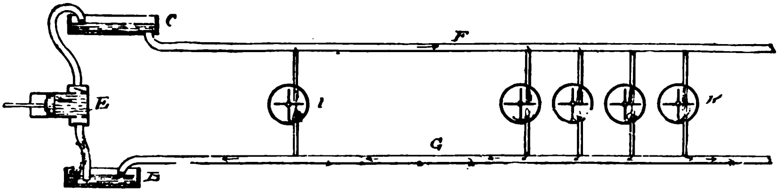

Fig. 4.—Water Analogue of Multiple Arc System.

It will be evident that the former system is the one better adapted to convey power to a distance, because, since the quantity of water is small and the fall great, a small flume or channel will suffice; while the multiple arc system would require a wide and deep channel, and each inch of fall in the channel would cause an appreciable loss of head. Where we have a fall of one hundred feet we can afford to use ten per cent. of it in carrying the water to a distant point, but when the fall is only ten feet, every inch is precious. This hydraulic comparison, though it may convey a practical idea of the subject, is not a perfect one, since the laws of water friction in flumes or pipes are very different from the laws of electrical flow through conductors. There are other technical differences which need not be considered in this connection, but it may be of service to say that while a water wheel can be constructed to work with either high or low pressure, with small or large flow of water, arc and incandescent electric lamps impose limitations upon both current and pressure. The amperes used by a standard arc lamp may vary from six to eighteen and the volts from thirty to forty-eight; below this limit the light grows dull and red, while above this it becomes blue and unsteady. The best commercial results in economy, color and steadiness are obtained from a lamp designed to operate with nine and a half amperes at forty-five volts pressure. An incandescent lamp is even more restricted in range. Taking a sixteen candle power lamp as a standard, it is at present impossible to get a carbon filament that will have a satisfactory length of life under a higher pressure than 125 volts, with a current of less than 0.38 amperes. The other limit would be a lamp requiring about 9.6 amperes under a pressure of 5.0 volts. It will be noticed that the same amount of power is absorbed by each of these lamps since the product of each pair of factors is 48 watts or $\frac{48}{746}$ of a horse power. It is desired to increase the resistance of the carbon filament, thus allowing increased pressure and decreased current, which would permit a smaller wire to be used for conductors. To get a practical idea of the value of pressure, it need only be remembered that a circuit to convey fifty horse power 1,000 feet to be utilized in arc lamps in series, with ten per cent. loss in conductors, would require but five lbs. of copper, though in service 100 lbs. would be used with one-third of one per cent. loss. It would require 3,222.72 lbs. of copper to convey to the same distance with ten per cent. loss, the same amount of power to operate incandescent lamps of 110 volts, in multiple arc; or 12,890.88 lbs. if 55 volt lamps were used. To carry the same amount of power double the distance with the same loss would require four times the weight of copper. Thus it will be seen that the great problem in electrical engineering is to reduce the amount of copper required without increasing the loss of power in transmission, and that there is a great temptation to use dangerous pressures in order to reduce the cost of copper conductors.

Two combinations of the series and the multiple arc systems have been devised, called by some the "multiple series" and the "series multiple." These require no more copper than the series system, but their disadvantage is that no lamp or motor can be turned off without altering the amount of current received by all the others, unless it be replaced by an equivalent resistance and its amount of energy wasted. This limits the use of these systems to fixed loads for prearranged hours (Figs. 5, 6 and 7). It is evident that if one of the lamps

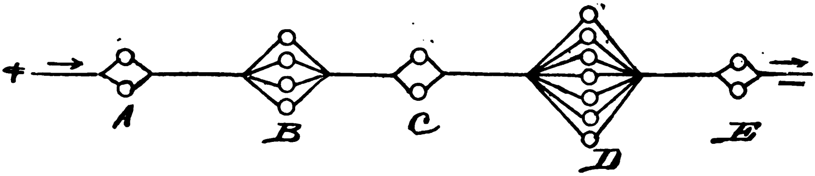

FIG. 5.—MULTIPLE SERIES SYSTEM.

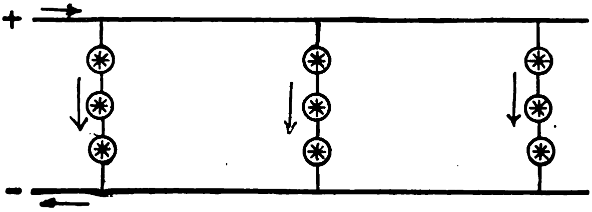

FIG. 6.—"SERIES MULTIPLE" SYSTEM.

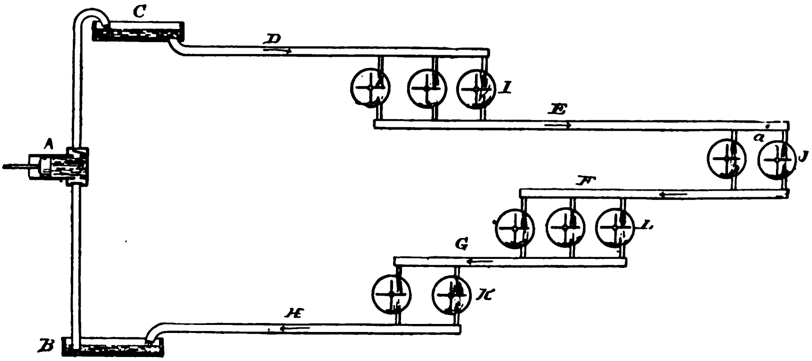

FIG. 7.—WATER ANALOGUE OF MULTIPLE SERIES SYSTEM.

in group A, Figure 5, should be turned off, the other lamp *would receive* the entire current, which is more than it could withstand; while if any lamp in Figure 6 should fail, the others in the same series would be extinguished.

Mr. Edison's three-wire system connects the negative terminal of one dynamo to the positive of the second dynamo; from this junction a central wire is carried out (middle wire of Fig. 8), and half the lamps are placed between it and a wire from the positive of the first dynamo (lower wire of Fig. 8), and the other lamps between it and the negative of the second (upper wire of Fig. 8). Thus each wire carries but half the current that would be needed if all the lamps were run from one machine; on that account but half the weight of wire is needed for each conductor. But at the same time we have twice the electromotive force at our service, since we have the sum of the pressures given by the two dynamos, and can therefore again divide the size of each wire by two, leaving the total weight but three-eighths of the amount required by the multiple arc system for the same number of lamps. And as no current will flow through the middle wire when the number of lamps is equally divided, its size may be reduced somewhat further.

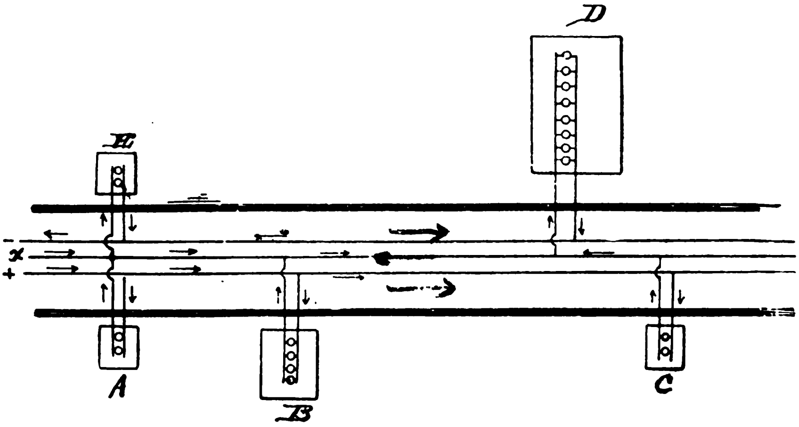

Fig. 8.—Three Wire System.

This system is far in advance of all others for use in closely built cities, but to give the best results it needs constant watching to keep the loads equally divided, and it requires too much copper to be used to advantage on long circuits through thinly settled towns. On the other hand, it entails no risk to life or health and can be readily operated under ground.

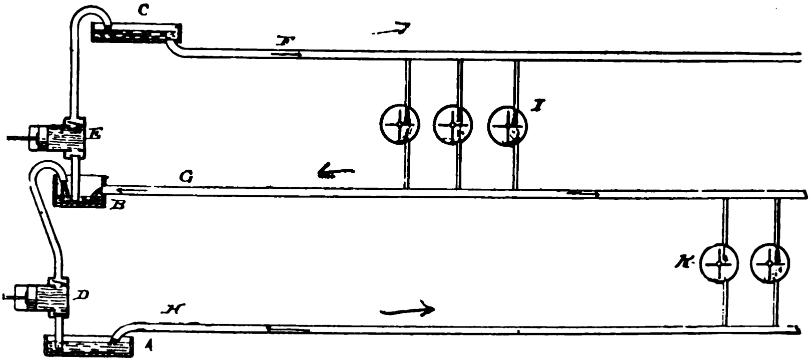

Fig. 9.—Water Analogue of Three Wire System.

As most of our smaller cities and towns are anxious to have the incandescent light, both on account of its many advantages and as a matter of local pride, there is a tremendous demand for a system that can choose the largest users of light in an area of many miles without requiring copper enough to dishearten the average investor. This has called into existence the alternating current or transformer system, which has come into very extensive use not only in country towns, where, if anywhere, there is a legitimate field for it, but even in large cities, where every reason founded upon safety, economy or dividends is clearly against it.

The alternating current system is based upon the fact that when an electrical current is set up in a conductor, it produces, by what is called induction, an electrical impulse in the reverse direction in any closed circuit parallel to the first; and when the current is broken in the first or primary wire, it induces in the secondary circuit a current in the same direction.

The same results are produced, though with less energy, when the primary current pulsates; but the greatest effect is given when it alternates. This effect is intensified by wrapping both the primary and secondary wires around a core or helix, which should form a closed magnetic circuit and be composed of thin insulated layers of iron. By using the same number of turns and size of wire in both coils the currents in each circuit may be made approximately the same; or if the primary has ten times the number of turns of the secondary, the latter will have a current with about one-tenth the pressure and ten times the volume of the primary current. A current of low tension and large volume may thus be obtained for lighting, heating or welding, or the process may be reversed and high pressure obtained.

This apparatus, which is called a transformer or converter, may be connected in series or in multiple on a primary circuit through which flows an alternating current under high pressure. A small wire or pair of wires will convey the current for several miles with but little loss in transmission. I must admit that the slight cost of primary conductors for a single dynamo, the apparent simplicity of the system and the ease with which converters may be inserted wherever incandescent lamps are needed, makes it exceedingly attractive. Some of the promoters of the system have fairly gone wild over it and are making fabulous claims as to its economy and efficiency,—claims which, if true, would revolutionize the age by giving us perpetual motion. Their sanguine enthusiasm has made an army of converts, many of whom expect to be overwhelmed in a golden stream of dividends.

But business men are not alone in yielding to the seductive charms of this system, for it has induced in the minds of many prominent electricians a fanatical enthusiasm which is almost a fetish worship. And when, a year ago, the writer called public attention to the deadly character of the alternating current, the heretic was assailed from all sides with a burst of invective and denunciation. It is not my province to lie in wait for "electric sugar" schemes, and I should not have felt called upon to protest had this dangerous system not been introduced as safe and harmless. Hear what its advocates have publicly and officially said of it; I quote from letters presented at a hearing before the New York Board of Electrical Control and published in the *Electrical World*, of July 28, 1888:

"The alternating current, while disagreeable, is far less dangerous to life than a direct current of the same tension. Personally I have received the full thousand volt current from an alternating current machine, not once but half a dozen times, and I have received the direct current in the same way, and, while the direct current would always make one sick for some time after the shock, the alternating current leaves no such effect." T. CARPENTER SMITH, of Westinghouse Co.

"Opening the circuit and introducing one's self into it merely subjects one to the pressure of 1,000 volts, which has never yet proved fatal."

S. C. PECK, of Thomson-Houston Co.

"No fatality can occur or serious inconvenience result, from a shock from an alternating current having a pressure of that already cited, 1,100 volts."

M. M. M. SLATTERY, Ft. Wayne Jenney Co.

"I have myself received 1,000 volts without even temporary inconvenience."

".... up to the present time no accident to life or property has been recorded."

".... our system has safeguards, which make it *absolutely safe* to life and property."

O. B. SHALLENBERGER, Electrician Westinghouse Co.

"An alternating current is far less dangerous as to fire or life risk than a current of what is known as the continuous or direct current type."

"The effect of the alternating current is immensely less, both as to burning and possible death, than the direct current of the same volume and pressure."

H. M. BYLLESBY, Gen'l Manager Westinghouse Co.

"In order that any danger, not of death, but of shock, could occur to any one, it would be necessary to take hold of both wires (and they should be bare at that, while those we use are thoroughly insulated) in order to obtain a current through him and to the ground."

THE SAFETY ELECTRIC LIGHT CO., (Westinghouse.)

> "There is even reason for supposing that the alternation of current would tend to prevent destructive effects, each current tending to undo the work of its predecessor."
>
> EAST RIVER ELECTRIC LIGHT CO.

Hearing these statements one would conclude that the alternating current was gentle and harmless, but the records show that prior to the date of the writing of these letters, there had been killed by the same alternating current, two men in Paris, one on the Czar's yacht, one at Buffalo, N. Y., one at Trenton, N. J., five at New Orleans, La., one in St. Paul, Minn., and one at Lincoln, Neb.

Since the risk in the public use of a deadly agent is increased a thousand fold if its promoters sell it as safe, I feel that I am justified in using all possible means to educate the public to distrust both the system and its owners. This, in connection with the bitter personal attacks made upon me, is the cause of my activity in the matter.

It is undoubtedly true that many of the persons around an alternating current station have taken slight shocks without injury, just as a plumber can brush his hot soldering iron with his finger tips without getting burned. But when I gave the most vehement advocate of the alternating current an opportunity to publicly demonstrate his faith in his statements by taking the alternating current from hand to hand for the same length of time and at the same pressure that I would first take the continuous current, before a committee of experts, he carefully ignored the letter and showed that he did not dare to risk his life.

My charges against the alternating current were sustained by most convincing proofs, and the makers of alternating current apparatus, with but one prominent exception, have recently instructed their agents to sell it as dangerous. With these companies I have no further quarrel, since the public, when warned of the danger, must assume the responsibility of its own selection and carelessness. But no honest man can approve of a person who states, over his official signature, that

> "The usual points of contact in accidental shocks received from electric circuits are through the hands, or some other

portion of the body protected by tissues of greater or less thickness, and, as a matter of experience, it has been found that pressures exceeding 1,000 volts (alternating current) can be withstood by persons of ordinary health, without experiencing any permanent inconvenience."

GEO. WESTINGHOUSE, Jr.,
Prest. Westinghouse Electric Co.,
(N. Y. *Evening Post*, Dec. 12, 1888.)

Let me show the result in trusting this statement; I quote from the Dallas *News* of April 24, 1889:

"Last night, about 8 o'clock, Thomas Madigan, a plumber in the employ of A. McWhirk, lost his life in the cellar of the Grand Windsor Hotel in a manner which illustrates the danger of coming in contact with electric wires. It appears that the unfortunate man, at the hour above stated, while standing on a pump designed to raise water with which to work the hotel elevator, lost his footing, and, to save himself from falling, seized one of the Queen City Company's electric wires that was trailed to the roof of the cellar. His hands were wet, owing to which, and the forming of a ground connection by the pump and the water pipe, the electric current was discharged into his body.

"He fell to the floor with a scream and died within ten minutes. His hands were horribly burned and the remains gave out the odor peculiar from a body struck by lightning. Mr. Henry Garrett, the electrician in charge of the Queen City Electric Light Works, said the wires are insulated with the regular waterproof covering."

Correspondents of mine, who were in the room soon after, could find no break in the insulation, though there must have been some pin-hole made by the discharge itself, which escaped their notice. This was a thousand volt alternating current.

I ask the lawyers and physicians in this assembly what would be the fate of a druggist who occasioned the loss of twenty or more lives by selling arsenic in bottles labeled: "This powder is sweeter than sugar and can be taken without permanent inconvenience by any person in ordinary health."

As a result of my experiments and the wide publication which the press has kindly given them, the danger of the alternating current is admitted by all excepting Mr. Westinghouse and his employes. In view of this fact, there was never a finer example of the bitter irony of fate than the legal adoption by the State of New York of the safe and harmless Westinghouse current for electrical executions. This use cannot fail to convince the public that this current and its promoters must be cautiously dealt with, and that the greatest safety lies in confining the former to the penitentiaries.

For this reason I have done all in my power to place Westinghouse apparatus in the prisons at Sing Sing, Clinton and Auburn. The Dallas case of death by the passage of the alternating current through waterproof insulation is a remarkable one, but it was closely followed by a similar fatal accident, on May 8, in the North River Tunnel. The victim, a laborer named James Maroney, seated himself on the air pipe, leaned back against the insulated wire from an alternating current machine and was instantly killed. The insulation was of the very best character.

These cases accentuate the special danger of the alternating current system, which is the difficulty, nay, the *impossibility*, of maintaining the insulation of its conductors. A continuous flow of water may be passed through a system of pipes under heavy pressure and at high speed, without starting a leak through its joints. But should its flow be suddenly checked or reversed its momentum would force every joint, if it did not shatter the pipe itself.

In the same way a continuous current of electricity, though under high pressure, may be easily kept to its path by suitable insulation, but the rapid reversals of the alternating current subject the insulation to a tremendous strain,—an actual molecular vibration, which tends to break down the insulation and permits or causes actual leakage of the current. A test of the wires of one of the systems in this city, using a pressure of 1,000 volts, showed nearly 800 volts between either wire and the earth. As 140 volts pressure with the alternating current has produced fatal results, this fact is a very unpleasant one; it means that any person touching a wire in contact with these conductors runs a terrible risk.

This rapid charge and discharge of the conductor produces a corresponding effect upon the metal armor of the insulation, if any is used, or upon the moisture surrounding the insulation if the wires are placed underground, or on overhead lines during wet weather. We have, in fact, an enormous Leyden jar or condenser, in which the conductor serves as the inner foil, the insulation as the glass partition, and the moisture or armor as the outer foil. These are in a state of constant tension, and their static capacity is of course dependent upon the area of the surfaces exposed and the character and thickness of the insulation. Indeed, a system of converters for electric lights and motors has been patented which is based upon this principle, and the enthusiastic inventor actually proposed to connect one terminal of his condenser converters to the earth. This, if adopted, would bring rapid wealth to coroner and undertaker.

It is undoubtedly true that both Madigan and Maroney lost their lives by a static or Leyden jar discharge which pierced the insulation and established a path for the current itself. This means that when the wires of the alternating current system are placed underground, as is the case at Dallas, their entire insulation surface, whether surrounded with the moisture of the earth or with lead pipes, becomes an immense condenser, which is ready at any moment to discharge through the body of any person touching the house wires while standing on a ground connection, if there is any weak point in the converter insulation. Indeed, it may even puncture the insulation, as it is well known that a discharge of static electricity can be made to leap several inches through the air or to force its way even through plate glass. If these wires are above ground the same effect may be produced during wet weather, as is shown by the death of Charles Devlin, in New Orleans, on Nov. 17, 1888. At about 8 o'clock on a foggy morning, a lowered arc lamp struck his cheek while he stood on a wet pavement, and he was instantly killed. Investigation showed that the arc dynamos were *not* running, but the alternating current wires, which were carried on the same line of poles, were in service. This condenser discharge is very marked during a thunder-storm, and converters and dynamos are frequently burned out in this way. Occasionally the discharge is made to telephone or telegraph circuits with disastrous results.

Disregarding for a moment the danger question, it is evident that there is a considerable loss of current due to this cause, the amount of which has never been determined, but careful tests will soon settle the question. In many other ways losses are incurred in this system, which finally overcome all its apparent advantages. In the first place there is probably such a thing as inertia in conductors, which makes it require less power to start and maintain a continuous current than to set up a flow in one direction, stop it and set up another in the opposite direction.

Continuous current dynamos are in daily use which have a commercial efficiency of at least 92 per cent., while the Westinghouse alternating current dynamo gives not more than 75 per cent. at full load, which leaves, on this account alone, 17 per cent. against the alternating current. In this and the following figures concerning this system I quote from the report of Prof. J. H. Denton, of Hoboken Institute of Technology, made to the Society of Gas Lighting, and suppressed presumably on account of the gloomy facts presented, lest the price of stock should be affected.

At the Pittsburgh tests, made by Prof. Denton without converters, 10.97 lamps of 16 c. p. each per belt horse power were obtained (see p. 36) with the Westinghouse dynamo, whose efficiency is 75 per cent. at full load (see p. 56). From these data we find that 14.626 of these lamps can be obtained from one horse power. 500 of these lamps from 10 converters of 50 lights each would therefore require 34.185 actual horse power delivered from the converters to the lamps.

There is a loss of 8½ per cent. in the converters themselves at full load (see p. 36), and the 10 converters will therefore require 37.36 horse power in their primary coils. The Westinghouse dynamo, at full load, has but 75 per cent. efficiency (see p. 56), and to deliver 37.36 electrical horse power it must absorb 49.81 horse power. To operate 500 of the same lamps from a continuous current dynamo with 92 per cent. efficiency would require but 37.15 horse power. This indicates a loss for the Westinghouse system of 12.66 horse power for 500 lamps; it therefore requires *one-third more power at full load* than the *same* number of lamps from a *continuous* current system.

At half load, 10 of the same converters with 25 lamps each would require 17.093 horse power for the lamps themselves; there is a loss in the converters at half load of 14 per cent. (see p. 37), and therefore 19.875 horse power must be delivered to the converters. The Westinghouse dynamo at half load has but 60 per cent. efficiency (see p. 55), and it therefore requires 33.125 horse power to drive the 250 lamps. Whereas with the continuous current dynamo, having 86 per cent. efficiency at half load, the 250 lamps would require but 19.875 horse power. The Westinghouse system therefore requires *two-thirds more power at half load* than the continuous current system, and at a lighter load the showing is even worse. In Cuntz and Wagner's report on the Westinghouse system (see p. 4), it is found by dynamometer that one lamp on a forty light converter requires 0.393 horse power, after deducting the friction of the dynamo itself. If every house had but a single lamp burning on each converter there would be *less than three lamps* of sixteen candle power obtained from *one horse power.*

With smaller converters the loss at minimum load would be less, but, on the other hand, the loss at maximum load would be greater. When it is remembered that the heaviest demand upon an electric light station is for *but one hour out of the twenty-four*, and that the entire number of lamps in any one building is seldom if ever burned at once, the lack of economy is very apparent. It is also very evident that Mr. Westinghouse had good reasons for making no reply to my letter of April 4, in which I called attention to his advertisements claiming that his electric lighting system gave "fifty per cent. more light from a given expenditure of power (fuel)" than could be obtained from the direct or continuous current system. I offered to purchase his apparatus at list price to present to the Johns Hopkins University, if a thorough test of both systems at the University Electrical Testing Bureau should verify his claims. I could not resist the suggestion that, if power could be converted from one form to another and fifty per cent. gained in the operation, perpetual motion was at his command. There was no reply, though the advertisement was withdrawn, and I am having the test of his apparatus made for my own information.

The only remaining advantage of this promising system is its apparent saving in weight of conductors, but even this will not stand investigation, since lamps of 50 volts are used and the secondary or house wires will weigh four times as much as is required in the multiple arc system with 100 volt lamps, or 10⅔ as much as is needed in the three wire system. The economy of its primary wires would be entirely neutralized if the complete lighting of a circle with but one mile radius were undertaken, the blocks being of the size of those in this city above Fourteenth street, and 1,200 lights allowed to each block. Using the *standard* tables of the Westinghouse and the three wire system, the former would require 9.3 lbs. of copper per lamp for feeders, 4.5 lbs. for mains, 1.0 lb. for converters and 32.0 lbs. for house wiring, or 46.8 lbs. in all. While the three wire system, with 110 volt lamps of same economy, would need 21.4 lbs. per lamp for feeders, 1.5 lbs. for mains and 3.0 lbs. for house wiring, or a total of 25.9 lbs. The total number of lamps in the district would be 980,000, requiring 45,864,000 lbs. of copper with the Westinghouse system, or 25,382,000 lbs. with the three wire system.

In practical service it is impossible to operate two alternating current dynamos, whose alternations exceed 200 per second, on one system of wires; therefore a pair of wires must return to the station for every group of lamps equivalent to the capacity of the largest dynamo, which is at present 1,200 in this country, though larger ones are projected. Increasing the dynamo capacity will not remedy this, as the weight of the wires must be correspondingly increased. To offset this, higher pressure is suggested, and in several towns in this country 2,000 to 2,500 volts pressure is used; but a system is under construction in England which proposes to use 10,000 volts. If 1,000 volts pressure of the alternating current *kills through water-proof insulation*, what can be expected of this outrageous pressure? An Irishman suggests that it will kill more English than dynamite and be at once ascribed by the London *Times* to the Home Rule Party.

In the past year electrically propelled street car systems have achieved a financial success and in several cases have, from the start, paid better returns on investment than when horses were used. The storage battery system is, of course, the best adapted for city use, as its power is self-contained; but it utilizes a less proportion of its motive power than the others, and its annual percentage of depreciation is not yet determined by the test of time.

The conduit system seems next on the list, as its conductors are out of the way; but the difficulty in maintaining the insulation is a serious drawback. The system using a single roller or trolley touching a bare overhead wire, with the rails as a return conductor, has been the most successful. As yet they have used only the continuous current with but 500 volts pressure, and the system involves no risk to life. But the use of the rails as a return is inadvisable in a city, since a telephone or telegraph wire, by falling upon the bare conductor, would establish a path of low resistance to the ground, and would therefore receive a heavy current which would destroy the instruments and perhaps start a fire.

With *two* overhead wires and a double trolley this risk would be greatly diminished. The alternating current motor, when it is made an economical success, will have one great advantage for street car use, since it requires neither commutator nor brushes. But the idea of a bare wire carrying the alternating current through our streets is a most horrible one; this must be prevented at all hazards. The attempt will undoubtedly be made, and the people who undertake it will unhesitatingly guarantee that it is "perfectly safe."

Aside from this, the tendency to constantly increase the pressure is the most serious danger of modern city life, and yet no attention is paid to it. Boards of Health look sharply after plumbing and drainage which can cause death only after giving long-continued warnings to its victims; they promptly *suppress rendering* establishments whose odor is offensive but not deadly; they override all personal rights by isolating cases of catagious diseases; and yet not a move has been made to secure protection against a measure of false economy which has slain its hundreds. A hundred families have been robbed of bread-winners and few coroners have been bold enough to even mildly censure the offending corporation. Under the law, steam boilers whose explosion can inflict death in but a limited area are carefully watched and inspected; the storage of oil, powder or dynamite in cities is prohibited and food adulteration checked; but dangerous electrical systems are allowed to enmesh an entire city with the executioner's current which seeks the earth by every channel.

Ought we, as law-abiding citizens, to submit tamely to this constant and ever-increasing danger to the lives of those dear to us? Must we abandon telephone and messenger call lest their wires bring the deadly current into our homes, and wait in fear and trembling until, among other hundreds of victims, there is killed some prominent man whose wealth and influence will rouse the authorities to action? It is probable that this may soon occur, as the building of the New York Bar Association is to be lighted with the alternating current system, and only a thin layer of questionable insulation will keep from some of our most prominent jurists an electric summons to appear before the Most Supreme Court.

Is it not our duty to unite in preventing a wanton sacrifice of human life, as physicians would do were it a new and contagious disease, or lawyers if it were a legal error placing innocent men under danger of a death sentence? I earnestly ask your assistance in putting an end to this needless slaughter, and it will require but a determined effort on your part to stop it.

If you will appoint a medico-legal committee to make an examination into this matter I will gladly place at its disposal the apparatus necessary to conduct thorough experiments. If you will but censure by your vote the commercial use in cities of dangerous pressures, this action by so eminent an assembly will encourage some fearless coroner to recommend an indictment for manslaughter and thus put a check upon reckless corporations. Or it would have great effect if you would carefully consider and urge in a resolution the adoption of a law prohibiting the use for any purpose except electrical executions, of any alternating electrical current with electro-motive force sufficient to produce death in a human being by leakage to earth from the conductors carrying such current; placing upon the police or boards of health the enforcement of the law, and, in case of their neglect, allowing any citizen of the threatened district power to secure its enforcement.

It will, of course, be said that a powerful lobby would oppose the passage of such a law; true, for the association of high-tension and alternating current local companies has already appointed a committee having a member in every State, whose duty is to raise the alarm on the introduction of any law aimed against the electrical murder of innocent men. But this same association censured the writer for his zeal in the cause of public safety, and resolved that the alternating current was not dangerous, and that no current under their control should be used for the "ignoble purpose" of painless electrical execution. This resolution caused the State authorities to choose the alternating current as necessarily the best adapted for the purpose, and placed the purchase of their apparatus in my hands.

They also did their best to defeat, in the New York Legislature, the appropriation for the purpose of purchasing the execution apparatus, thinking thereby to nullify the law, and they succeeded in obtaining a unanimous vote—*for* the appropriation, in which even those members opposed to capital punishment joined, rather than give cause for suspicion.

One can hardly imagine a more ridiculous position than would be occupied by this committee when appearing against this proposed law. Their generous offers of financial aid to overworked legislators would be received with an unanswerable question: "Your President, General Manager, Electrician and other officers and employes have constantly maintained that your current is perfectly safe and harmless. You appear *opposing* the passage of a law prohibiting none but *deadly* currents. If your statements are true you have no business here, as the law will not affect your interests; if your current is deadly, what attention should be paid to you or your statements?"

It may be said that this movement is aimed against a wealthy and powerful corporation which will spend money like water in its defeat. True, money may throw dust in the eyes of the coroner for a time; it may deceive the press concerning facts; it may silence the voices of mourning relatives, even though they stand high in social and educational circles; it may procure temporary advantages and rights of way; but it cannot forever permit the electrical slaughter of inoffensive men to go unpunished; it cannot defeat the passage of a law whose sole object is the *preservation of human life.* The legislator who voted in the negative on this question would sign his political death warrant.

What hardships would such a law inflict and upon whom would the burden fall? It would simply require the reduction of the pressure from 1,000 volts to about 300; it would necessitate the use of additional copper conductors weighing 2⅓ times as much as those now in use, thus requiring a small additional investment on the part of corporations who have received the free use of the public streets. It would benefit no particular corporation, since the continuous current can be and is used by all the electric light companies, and there is no foundation patent upon the alternating current.

It is true that some electricians claim that such a law would cause many lighting stations to go out of business; I doubt this for high-tension continuous current systems with converters or secondary dynamos would prove more economical than the high-tension alternating current system under the average load; but, even if it did, it would be better to shut them all down and go back to gas and kerosene, rather than keep up this needless sacrifice of life. Others say that newly invented apparatus can be applied which will make the alternating current safe.

This seems an impossibility; but I shall take the first opportunity to make a thorough test of it. Should it prove efficient, I will gladly admit it and urge its immediate adoption. Even if it is true, the proposed law would not interfere with the use of a current which could *not* produce death by leakage to earth; but, from the history of the reluctance of corporations to spend money in order to protect life, such a law would be necessary to secure the adoption of the safeguards. In spite of the frightful car stove fatalities, it required a law forbidding its use before the railroads would abandon them in this State.

I cannot close without referring to another danger which may confront us at any moment. On April 24th, a fireman named James Carney was at his work at a fire in the city of Pueblo, Colorado. He touched an insulated wire from the Westinghouse electric light station and was instantly killed. The firemen in our large cities have not yet learned that, in the presence of water, the indoor wires of the alternating current systems can prove fatal. Should such an accident as this occur at a large fire in this city, a panic among the firemen might naturally result and a tremendous sacrifice of life and property teach a terrible lesson. In conclusion, I ask your assistance in the protection of the greatest of human rights —the right to life.

HAROLD P. BROWN,

45 & 47 WALL ST., N. Y. ELECTRICAL ENGINEER.

June 4, 1889.

PARTIAL LIST OF DEATHS

— FROM —

ELECTRIC LIGHTING APPARATUS.

This list, which contains less than one-half the total number of deaths from this cause (or only those the details of which I have been able to obtain during the past year), has been carefully compiled by correspondence and conversations with electric light employees, coroners, city authorities, telephone or telegraph managers, reporters or other witnesses. Any additions or corrections will be considered a favor, but it must be remembered that the officials or employees of the company whose apparatus caused a fatality will do their best to shield themselves. If it is an alternating current company, the blame will be placed on some arc light circuit; if it is an arc light company the fatality will be laid to "heart-disease," to the "fall" or to the man's own "carelessness."

Coroners will do well to remember that death from a properly insulated and equipped arc light circuit cannot occur, unless the subject actually gets into the circuit (no one but an employee is likely to do this); that deaths by touching the circuit at a single point show that the wire is not properly insulated, and that the means for detecting ground connections are inefficient; and that a death from an electric shock is almost invariably indicated by the fluid condition of the blood.

The writer wishes again to call attention to the following facts, which have been fully demonstrated by his experiments and explained in his pamphlet, "The Comparative Danger to Life of the Alternating and Continuous Electrical Currents:"

1. Any arc light circuit may be made safe to the public

by the use of apparatus, suggested by the writer, to detect ground contacts and to protect against the "extra current".

2. No apparatus or device can make safe the alternating current used at more than 200 to 300 volts pressure.

3. The continuous current can be kept to its path by proper insulation.

4. No insulation can confine the high-tension alternating current to its conductor; witness the killing of EDMUND RAMEY, JAMES MARONEY, THOS. MADIGAN, JAS. CARNEY and others by a discharge through *insulated wire* of the best character.

5. The continuous current for arc lights was extensively used for five years without killing any one.

6. The alternating current has been used on an extensive scale for less than two years in this country, yet it has already killed more than twenty-five persons. As the insulation wears away and the plants are extended, the death list will be rapidly increased, unless action is taken to prohibit dangerous pressures.

HAROLD P. BROWN,
Electrical Engineer.

Atlantic City, N. J.—LOUIS MUND, age 14, killed while playing on the roof of Albrecht's Hotel, Aug. 8, 1888, by contact with grounded pulsating current circuit.

Austin, Tex.—EDMUND RAMEY, porter in billiard hall, killed on roof Aug. 27, 1888, by touching insulated wire on Westinghouse alternating current circuit.

Baltimore, Md.—JAS. HAISLIP, killed Oct. 14, 1888, by touching grounded Brush (pulsating current) circuit.

Brooklyn, L. I.—CHAS. WATSON, killed Nov. 13, 1888, by getting into pulsating current circuit.

Buffalo, N. Y.—ISAAC MORTON, porter Wagner Palace Car Company, killed Feb. 5, 1888, by touching telegraph wire hanging over insulated Westinghouse alternating current circuit.

Canandaigua, N. Y.—ELMER E. WOOD, Manager Electric Light Company, killed Dec. 4, 1887, by getting into high-tension continuous current circuit.

Charleston, S. C.—WASHINGTON COAXUM, carpenter, killed on roof of Western Union Telegraph building, on Dec. 16, 1888, by touching insulated wire carrying alternating current.

Chicago, Ill.—(Mem. All electric light wires in this city are underground.)

Salesman WILLOUGHBY, HILL & Co., killed in elevator shaft by ground on Brush circuit.

CHAS. SCHULTZ, employee same firm, killed by ground on Brush circuit.

A. C. HOLLAND, killed at Lansing & Sickler's, while adjusting fan motor; got into high-tension continuous current circuit.

CHAS. MOELLER, engineer Electric Light Company, killed by ground on pulsating current circuit.

Unknown man found dead in basement Globe Hotel; had got into high-tension continuous current circuit.

Employee Electric Light Company, killed under sidewalk by ground on pulsating current circuit.

OSCAR G. CLARK, employee T. & H. Co., killed Oct. 4, 1888, by getting into pulsating current circuit.

Cincinnati, O.—JAS. O'CONNELL, Stage Manager at Harris' Museum, killed Dec. 11, 1887, by ground on Brush circuit.

WM. BOGARDUS, house painter, killed while at work, on Oct. 1, 1888, by ground on Brush circuit.

DELANCENT MCMUNN, employee Brush Company, killed Oct. 19, 1888.

Cleveland, O.—Visitor at Brush station, killed by getting into circuit.

Dallas, Tex.—THOS. MADIGAN, plumber, killed while at work in Grand Windsor Hotel, on April 23, 1889, by shock through water-proof insulated wire carrying alternating current.

Dayton, O.—Superintendent Electric Light Company, killed by getting into high-tension continuous current circuit.

Detroit, Mich.—HIRAM CORLISS, employee Brush Company, killed Oct. 3, 1887, by getting into circuit.

WM. E. FORBES, employee Brush Company, killed Jan. 3, 1889, by ground on circuit.

Five other employees of Electric Light Companies; pulsating current.

Fostoria, O.—HARRY L. HOGUE, Sup't Brush Company, killed April 2, 1889, by touching grounded circuit.

Halifax, N. S.—Two linemen, killed by grounded pulsating current circuit, during first week in July, 1888.

Hartford, Ct.—Expert of Electric Light Company, killed by grounded pulsating current circuit.

Hatfield House.—WM. DIMMOCK, laborer, killed by grounded Brush circuit.

Hoboken, N. J.—JOS. O'NEILL, lineman Electric Light Company, killed Aug. 8, 1888, on pole having both pulsating and Westinghouse alternating current wires; character of burns and fact that arc lamps were not running would indicate that the latter killed him.

EDWARD BOGART, lineman Electric Light Company, killed Aug. 3, 1888, by Westinghouse alternating current.

JAS. MARONEY, laborer in North River Tunnel, killed while at work, on May 9, 1889, by touching water-proof insulated secondary wire conveying the alternating current.

Jamestown, N. Y.—Employee Electric Light Company, killed by getting into pulsating current circuit.

Lincoln, Neb.—Unknown man, killed by trailing alternating current wire, early in 1888.

Lynchburg, Va.—Lineman, killed in September, 1887, by getting into high-tension continuous current circuit.

Lynn, Mass.—HARRY LOVEITT, Expert T. & H. Company, killed March 30, 1888, by getting into pulsating current circuit.

Marinette, Wis.—Supt. Brush Co., killed by touching grounded circuit.

Memphis, Tenn.—JAS. MCGINNIS, barkeeper, killed Sept. 22, 1888, on the street, by touching dangling telegraph wire in contact with alternating current circuit.

WM. SUMMERVILLE, boy, killed Feb. 6, 1888, by touching grounded Brush circuit.

Minneapolis, Minn.—Three employees Electric Light Company, killed by touching grounded pulsating current circuit.

New Orleans, La.—Employee Brush Company, got into circuit and was killed in September, 1887.

HENRY BOERCHER, telephone lineman, killed Oct. 18, 1887, by drawing iron wire over Westinghouse alternating current circuit.

Employee Edison Co., killed October, 1887, by Westinghouse alternating current.

EDWARD MYHAN, employee Electric Light Company, killed Aug. 8, 1888, by alternating current.

Two other employees Electric Light Company, killed by Westinghouse alternating current.

JOHN KRUSER, inspector Electric Light Company, killed Jan. 7, 1889, by Westinghouse alternating current.

CHAS. DEVLIN, killed Nov. 17, 1888, by touching with his head a wire in contact with Westinghouse alternating current circuit while standing on a damp sidewalk.

New York City.—J. T. SIMPSON, engineer Adams Express Co., killed May 6, 1887, by touching grounded pulsating current circuit.

WM. MEIER, engineer same company, killed July 16, 1888, by touching same circuit.

Lineman SIMONDS, killed at a fire on Fulton street, by getting into U. S. Company's circuit; high-tension continuous current.

Waiter in Atlantic Beer Garden, killed by ground on Brush circuit.

Jos. STAMANS, killed in December, 1886, by ground on Brush circuit.

GEO. SCHNEITZER, employee Harlem Electric Light Company, killed Oct. 24, 1887, by touching grounded pulsating current circuit.

MEIER STREIFFER, peddler, killed on East Broadway, April 14, 1888, by touching hanging telegraph wire in contact with U. S. Company's circuit.

THOS. H. MURRAY, expert Brush Company, killed May 11, 1888, by touching grounded Brush circuit.

FRED. WITTE, clothing salesman, 200 Bowery, killed April 28, 1888, by touching grounded U. S. Company's circuit.

AMBROSE HILBERT, boy, killed Dec. 11, 1887, by touching hanging telegraph wire which was in contact with grounded pulsating current circuit.

NELSON RICHARDSON, laborer in new aqueduct, killed Aug. 12, 1888, by touching grounded pulsating current circuit.

ROBT. MUTRIE, tinner, killed on roof of building on Sept. 8, 1888, by touching grounded pulsating current circuit.

CHAS. HEATES, killed Jan. 9, 1889, by shock from alternating current circuit; fell and fractured his skull. Either injury was sufficient to cause death.

MICHAEL RYAN, killed Jan. 27, 1889, by touching grounded pulsating current circuit.

EDWARD QUINN, foreman Brush Company, killed June 28, 1889, by touching grounded pulsating or alternating current circuit.

Paris, France.—Two men, killed by alternating current at opening of Grand Opera House.

Philadelphia, Pa.—THEO. HIMMELMANN, boy, killed Dec. 18, 1888, at fire, by touching dangling telegraph wire in contact with grounded pulsating current circuit.

Pittsburgh, Pa.—ANDREW REARDON, telephone lineman, killed Aug. 7, 1888, by drawing iron wire over insulated Westinghouse alternating current circuit.

Portsmouth, O.—Engineer, killed by grounded pulsating current circuit.

Pueblo, Col.—JAS. CARNEY, fireman, killed at a fire on April 27, 1889, by touching Westinghouse alternating current circuit.

Rochester, N. Y.—Three employees Electric Light Company, killed by grounded pulsating current circuit.

St. Louis, Mo.—OLE ANDERSON, telephone lineman, killed March 13, 1888, by touching grounded pulsating current circuit.

W. R. RYDER, telephone lineman, killed April 14, 1889, by touching grounded pulsating current circuit.

R. ARCHIBALD, lineman, killed Feb. 29, 1888, by pulsating current circuit.

St. Petersburg, Russia.—Officer on the Czar's yacht, killed by alternating current.

Scranton, Pa.—EDWARD BROSS, lineman Brush Company, killed Aug. 8, 1888, by getting into circuit.

St. Paul, Minn.—JAS. ROBERTS, employee Electric Light Company, killed April 21, 1888, by touching Westinghouse alternating current circuit.

Employee same company, killed by touching Westinghouse alternating current circuit.

Syracuse, N. Y.—Man in Park, killed May 12, 1888, by grounded pulsating current circuit.

Terni, Italy.—Tinner on roof of building, killed in June, 1888, by touching alternating current circuit.

Toledo, O.—FRANK J. MYERS, cook, killed Dec. 24, 1888, while closing iron window shutter, which touched grounded pulsating current circuit.

Trenton, N. J.—Engineer Westinghouse Company, killed by touching Westinghouse alternating current circuit.

Turin, Italy.—Employee Electric Light Company, killed in December, 1888, by the alternating current.

Williamsburg, N. Y.—PATRICK McGUIRE, killed in December, 1886, by grounded pulsating current circuit.

Youngstown, O.—Employee Electric Light Company, killed by getting into pulsating current circuit.

RESUMÉ OF ABOVE LIST.

Number of deaths from arc light circuits during first five years of use—none.			
Number of deaths from arc light circuits during next seven years.....			64
Of which the pulsating current caused....		56	
And the high-tension continuous current caused....................		8	
Of these, grounded circuits caused.........................	42		
While within two years, with less than one-tenth the number of dynamos in use, the alternating current has killed...........			24
Add deaths by alternating current prior to 1887....................			3
Total number of deaths in above list.			91

Of the 64 killed by arc light currents, at least 50 could have been saved by the proper insulation and apparatus. No apparatus could have saved the 27 killed by the alternating current.

LEGISLATIVE CONTROL

—OF—

DANGEROUS ELECTRICAL CURRENTS.

Address by JOHN MURRAY MITCHELL, *Counselor at Law, before*
the International Medico-Legal Congress
at Steinway Hall, June 4th, 1889.

New York State has officially recognized that currents of electricity can produce death instantaneously, by replacing the hangman's noose with the electrical current as the greatest punishment which can be inflicted upon man for the worst of crimes he may commit.

It has been shown to us to-day what electrical currents may be dangerous, and I will not go into that subject, as it is not my province, dealing with the legal side of this issue, to enter into a discussion as to what currents may be dangerous, but only to maintain that such currents as have been or may be proved to be dangerous even where the best insulation has been employed, should not be tolerated in any place where unintentional death or injury to the individual could be caused. I use the word unintentional because we all know that death caused in this way is not caused intentionally, excepting in those cases where it has been prescribed by law as a capital punishment.

The history of modern development, both scientifically and legally, shows the increasing desire of the people for protection to life, limb and health, and the necessity for increasing care in this respect owing to the great increase in dangerous manufactures.

Should we compute the vast amount of time and money which has been expended practically, legislatively and legally to guarantee the greatest possible safety to the individual, we would doubtless find that the value of the time and money so expended would be equal to the total amount of money invested to-day in those enterprises which require these safeguards for the protection of the individual.

We find, for example, that protection has been thrown about the manufacture of explosives and the sales of poisons; that limitations have been placed on the quantity of oil in storage; that care is taken in the inspection of our buildings, plumbing and drainage, in the quarantine and isolation of infectious diseases, the inspection of steam boilers, keeping the highways clear, and in the general control and official regulation of "any business, matter or thing dangerous to life or detrimental to health."

While there is every reason to guard against the dangers which I have enumerated, there is far more reason for the restriction of the use of dangerous electrical currents.

In the manufacture of nitro-glycerine, gunpowder or other high explosives, and their commercial use and sale, we are confronted with a different problem from the one with which we are now dealing. These are articles of commercial use which are intended to be, are, and must be dangerous. They are valuable largely in proportion to their explosive power.

Electricity, however, may, for the purposes of this paper, be divided into two different classes without regard to alternating, intermittent or continuous currents, namely, currents which are HARMLESS and currents which are DEADLY.

For all the commercial purposes for which electricity is now used where great power is required or great distances covered and consequently where great danger may ensue, currents of such low intensity can be used that no one, not even the most sickly infant, could be injured thereby. I use the expression "sickly infant", because it is well known that the weaker the individual, the thinner and more delicate the cuticle and the more the danger to the individual when subjected to a great electric shock. A vigorous man starting for work in the morning after a healthy night's sleep, would be able to withstand a greater nervous shock than he could in the evening after a hard day's work.

The question therefore resolves itself to this: Shall we allow a dangerous electrical current to be used when a safe one can do the same work? The spirit of our laws is certainly against such a course.

We should not restrict the uses of electricity within unnecessary limits. It is far too great a benefactor to us to do this; but we should not allow it to commit unnecessary slaughter.

The extents to which harmless currents can be used and the limit of safety can be readily ascertained. Once found, the limits should never be exceeded.

It is not our purpose now to find what these limits are, but only to show that legal restriction should be placed about every *unnecessarily dangerous* current.

Granted, then, that safe currents will do the work necessary to be done by electricity, is it not as negligent to use a dangerous current as it would be if a ferryboat, railroad or other public carrier were to employ unsafe means of transportation or to fail to adopt safety devices for the protection of passengers or employes when such devices could be obtained?

All courts have held this to be negligence in the common carrier, and in Germany we find in the Criminal Code, Drage's Edition, 1885, page 253, Sec. 230, "Any one who has caused the bodily injury of another through negligence shall be punished by a fine up to 900 marks, or by imprisonment with labor up to two years." Our own Penal Code has a somewhat similar section:

SECTION 675, PENAL CODE.

"A person who willfully and wrongfully commits any act which seriously injures a person or property of another, or which seriously disturbs or endangers the public peace or health, or which openly outrages public decency, is guilty of a misdemeanor."

This is not, however, as strong as the German Code, a matter perhaps accounted for when we reflect that the German

Government itself is vitally interested in having each citizen protected at home, that there may be one man more to answer the call to arms when the time comes to fight for his fatherland. The continued peace of our country and our marvelous progressiveness makes us reckless of our lives; we are always ready to make up a purse for unfortunate sufferers, but we would be better citizens and neighbors should we compel those precautions to be taken which would prevent all needless loss of life and render unnecessary these voluntary contributions.

Witness the fearful catastrophe of last week, and its ensuing horrors.

England is ahead of us in electrical protection. Her Board of Trade passed provisional orders restricting the use of dangerous currents in 1884.

LIMITS OF STANDARD PRESSURE.

We find the following provisional orders regarding electrical currents: "(d) The standard pressure may be different for different points of any main, and with the approval of the local authority for different hours during the period of supply, but it shall in all cases be within the limits following:

"In the case of continuous currents it shall not be less than thirty volts or more than two hundred volts, and in the case of alternating current it shall not be less than fifty volts or more than one hundred volts."

PROVISIONAL ORDER, § 141.

"(m) The difference of potential at corresponding points of the positive and negative conductors used as distributing mains or service lines shall not at any time exceed two hundred volts in the case of continuous currents and one hundred volts in the case of alternating currents (the difference of potential in the case of alternating currents being taken as equal to the constant difference of potential which would in the case of continuous currents produce the same mean effect), and no portion of any such conductor shall be at a potential differing from the earth by more than such quantity."

I will here read an official letter from the Secretary of the Board of Trade.

"BOARD OF TRADE (RAILWAY DEPARTMENT),
LONDON, S. W., 19th July, 1887.

SIR: I am directed by the Board of Trade to acknowledge the receipt of your letter of the — June, applying for a copy of a regulation of this Department restricting potential of electric currents employed for power purposes to three hundred and fifty volts. * * * The cases in which it is proposed to employ electrical power for the propulsion of tram cars, &c., are dealt with by the Board of Trade according to the special circumstances of each case.

Where the public have access to the line, a maximum of two hundred and fifty volts has been allowed, cautioning notices being issued that it might be dangerous to touch the electrical rail.

Where the line is quite enclosed three hundred volts has been authorized, but, although this is the maximum that has been sanctioned up to the present time, it is probable that the Board of Trade would be prepared to authorize a difference of potential considerably in excess of this limit in special cases and with suitable precautions. I am, sir,

Your obedient servant,
COURTNEY BOYLE."

As we have no special legislation on this matter here, let us see how far the general principles of our laws give us right to protection in this matter.

Tiedeman, in his "Limitations of Police Power," states the following, page 17, sec. 10, under the title of

SECURITY TO LIFE.

"The legal guaranty of the protection of life is the highest possession of man. It constitutes the condition precedent to the enjoyment of all other rights. A man's life includes all that is certain and real in human experience, and since its extinction means the deprivation of all temporal rights and the loss of his own personality, so far as this world is concerned, the cause or motive for its destruction must be very urgent and of the highest consideration, in order to constitute a sufficient justification. If there be any valid ground of justification in the taking of human life, it can only rest upon its necessity as a means of protection to the community against the perpetration of dangerous and terrible crimes by the person whose life is to be forfeited. When a person commits a crime that trespasses upon the rights of his fellow men, he subjects his own rights to the possibility of forfeiture, including even the forfeiture of life itself, and the only consideration, independently of constitutional limitations, being whether the given forfeiture, by exerting a deterrent influence, will furnish the necessary protection against future infringements of the same rights. That is, of course, only a question of expedience addressed to the wise discretion of legislators, and does not concern the Courts. Except as a punishment for crime, no man's life can be destroyed, not even with his consent."

Under the title of

SECURITY TO LIMB AND BODY,

Sec. 12, page 22, we find:

"This right is as valuable and is as jealously guarded against violation as the primary right to life. Not only does it involve protection against actual bodily injuries, but it also includes an immunity from the successful attempts to inflict bodily injuries, a protection against assaults as well as batteries."

We are at present regarding protection against batteries alone.

It may be claimed by those using dangerous currents that they have vested rights which cannot be taken away from them.

In reply, hear what Tiedeman says on this:

LAWS REGULATING THE USE OF PERSONAL PROPERTY.

§ 140, p. 499.

"While personal property is protected by constitutional limitations against all unnecessary interference and regulations, it is a standard rule of police power that one must not make such use of his own property as to injure another, and consequently the use and enjoyment of personal property may be subjected to such police regulations as may be necessary to prevent any threatened injury to the public.

"The proof of the existence of a threatening injury, and of the appropriateness of the proposed regulation as a remedy, will always justify the interference. Its efficacy is not a matter of judicial consideration. Laws for the regulation of the use of personal property may be varied as to the uses to which such property can be put."

P. 500, §140 b.

"As a general proposition, it can hardly be doubted that one has a constitutional right to change the form and condition of his personal property to whatever extent he may think fit, and he may make a business of manufacturing a given article, provided he does not threaten the public with injury, and it may be safely stated that the manufacture of no useful article may be prohibited altogether. As has already been explained, in setting forth the various regulations that may be applied to trades and occupations, the manufacture of the article may be subjected to whatever regulations may be necessary to guard the public against injury in the process of manufacture, or afterwards in wrongful use of it. Those who engage in its manufacture may be required to submit to a certain examination, in order to ascertain their fitness for the business, and to take out a license if the manufacture requires such regulations. And if the danger to the public of a wrongful and illegitimate use of the manufactured article be so imminent as to call for such legislation, as seems very likely to happen with reference to the manufacture of dynamite, nitroglycerine and other like explosive compounds, the manufacture for the purpose of sale, that is, as a business, may be prohibited to all but a few licensed manufacturers or the agents of the State."

I feel that I cannot do better than to close my remarks with a few quotations from the case of The People *ex rel.* The

New York Electric Lines Co. Appellant *vs.* Rollin M. Squire as Commissioner.

107 N. Y. 603—Jan., 1888.

The companies on appeal claimed that the act compelling them to place their wires underground was obnoxious to the clause of the constitution which forbids the enactment of any law impairing the obligation of contracts.

Chief Justice Ruger wrote the opinion, in which he says:

"We are of the opinion, for other reasons, that this legislation did not and was not intended to materially impair or restrict the enjoyment of the franchise secured by the relator. The necessity of these acts sprung out of a great evil which in recent times has grown up and afflicted large cities by the multiplication of rival and competing companies organized for the purpose of distributing light, heat, water, the transportation of freight and passengers, and facilitating communication between distant points, and which require in their enterprises the occupation not only of the surface and air above the streets, but indefinite space underground. This evil had become so great that every large city was covered with a network of cables and wires attached to poles, houses, buildings and elevated structures, bringing danger, inconvenience and annoyance to the public. * * * * * The necessity of a remedy for these public annoyances had long been felt, and it finally culminated in the enactment of the several statutes referred to.

These statutes were obviously intended to restrain and control as far as practicable the evils alluded to, by requiring all such wires to be placed underground in such cities and be subject to the control and supervision of local officers, who could reconcile and harmonize the claims of conflicting companies and obviate in some degree the evils which had grown to be almost, if not quite, intolerable to the public. The scheme of these statutes was not to annul or destroy the contract rights of such companies, but to control and regulate their exercise. * * * * *

That regulations of the character provided for in these acts are strictly police regulations, and such as no chartered right can nullify or override, is too clear to admit of dispute.

The due and orderly arrangement of the various and conflicting claims to privileges in the streets of large cities would seem imperatively to require the creation of a neutral board with controlling authorities to form a comprehensive plan by which these various enterprises may be harmonized and carried on without detriment to each other and with due regard to the rights of the public.

An elementary writer has said that "the police of a State, in a comprehensive sense, embraces a system of internal regulations by which it is sought not only to preserve the public order and to prevent offenses against the State, but also to establish, for the intercourse with citizens, those rules of good manners and neighborhood which are calculated to prevent a conflict of rights and to insure to each the uninterrupted enjoyment of his own, so far as is reasonably consistent with a like enjoyment of rights by others."

Ch. J. Redfield, in Sharp *vs.* Rutland and Burlington R. R. Co.(27 Vt. 149), says: "This police power of the State extends to the protection of the lives, limbs, health, comfort, quiet of all persons, and the protection of all property within the State."

The right to exercise this power cannot be alienated, surrendered or abridged by the Legislature by any great contract delegation whatsoever, because it constitutes the exercise of a governmental function, without which it would become powerless to protect those rights which it was especially designed to accomplish.

Thus it was held in Presbyterian Church *vs.* City of N. Y. (5 Cowe, 540), where the corporation had granted with the covenant for quiet enjoyment a piece of land to the plaintiff to be used for church purposes and as a cemetery, that the power of a Municipal Government to pass an ordinance forbidding the use of such premises as a cemetery for the interment of the dead, constituted no breach of covenant."

In conclusion: We have seen the dread power of the unnecessarily dangerous electrical current. We all know the menace it is constantly to our lives, our health or our happiness. Let us, before more lives are lost, stop the increase of one, two or three of this Act upon any local board of health may be enforced by a mandamus at the instance of the State Board of Health, its president, secretary, or any member thereof, or at the instance of any citizen of the city, town, village or municipality in which such apparatus shall be used or operated contrary to the provisions of this Act.

SECTION 6. All Acts and parts of Acts inconsistent with this Act are hereby repealed.

SECTION 7. This Act shall take effect immediately.

JOHN MURRAY MITCHELL,
Counselor at Law.

45 and 47 Wall St.,
June 4, 1889.